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United States Patent [19]

Sinofsky

[11] Patent Number: **5,843,073**
 [45] Date of Patent: ***Dec. 1, 1998**

[54] **INFRARED LASER CATHETER SYSTEM**[75] Inventor: **Edward Lawrence Sinofsky**, Reading, Mass.[73] Assignee: **Rare Earth Medical, Inc.**, West Yarmouth, Mass.

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 4,917,084.

[21] Appl. No.: **411,581**[22] Filed: **Mar. 29, 1995****Related U.S. Application Data**

[60] Continuation of Ser. No. 49,147, Apr. 19, 1993, which is a division of Ser. No. 568,348, Aug. 15, 1990, which is a continuation of Ser. No. 257,760, Oct. 14, 1988, Pat. No. 4,950,266, which is a continuation of Ser. No. 14,990, Feb. 17, 1987, abandoned, which is a continuation of Ser. No. 761,188, Jul. 13, 1985, abandoned.

[51] Int. Cl.⁶ **A61N 5/06**[52] U.S. Cl. **606/10; 606/3; 606/7; 606/15**[58] Field of Search **606/2, 3-19; 600/104, 600/108**[56] **References Cited****U.S. PATENT DOCUMENTS**

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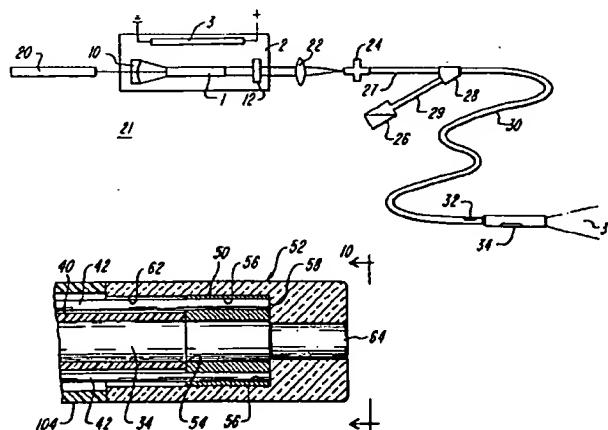
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"Reduction of Laser Inducted Pathological Tissue Injury Using Post-Energy Delivery", by L. Deckelbaum et al., vol. 56, Oct. 1, 1985, pp. 662-667. *

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Primary Examiner—David M. Shay**Attorney, Agent, or Firm**—Thomas J. Engellenner; Lahive & Cockfield, LLP[57] **ABSTRACT**

Laser energy produced by a laser operating in the mid-infrared region (approximately 2 micrometers) is delivered by an optical fiber in a catheter to a surgical site for biological tissue removal and repair. Disclosed laser sources which have an output wavelength in this region include: Holmium-doped Yttrium Aluminum Garnet (Ho:YAG), Holmium-doped Yttrium Lithium Fluoride (Ho:YLF), Erbium-doped YAG, Erbium-doped YLF and Thulium-doped YAG. For tissue removal, the lasers are operated with relatively long pulses at energy levels of approximately 1 joule per pulse. For tissue repair, the lasers are operated in a continuous wave mode at low power. Laser output energy is applied to a silica-based optical fiber which has been specially purified to reduce the hydroxyl-ion concentration to a low level. The catheter may be comprised of a single optical fiber or a plurality of optical fibers arranged to give overlapping output patterns for large area coverage.

13 Claims, 6 Drawing Sheets



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United States Patent [19]**Sinofsky**[11] **Patent Number:** **5,843,073**[45] **Date of Patent:** ***Dec. 1, 1998**[54] **INFRARED LASER CATHETER SYSTEM**[75] **Inventor:** Edward Lawrence Sinofsky, Reading, Mass.[73] **Assignee:** Rare Earth Medical, Inc., West Yarmouth, Mass.[*] **Notice:** The term of this patent shall not extend beyond the expiration date of Pat. No. 4,917,084.[21] **Appl. No.:** 411,581[22] **Filed:** Mar. 29, 1995**Related U.S. Application Data**

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